

From glowbugs@theporch.com Sat Sep 21 02:40:54 1996
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(CDT)
Date: Sat, 21 Sep 1996 02:35:24 -0500 (CDT)
Message-Id: <199609210735.CAA11342@uro.theporch.com>
Errors-To: ws4s@midtenn.net
Reply-To: glowbugs@theporch.com
Originator: glowbugs@theporch.com
Sender: glowbugs@theporch.com
Precedence: bulk
From: glowbugs@theporch.com
To: Multiple recipients of list <glowbugs@theporch.com>
Subject: GLOWBUGS digest 297
X-Listprocessor-Version: 6.0c -- ListProcessor by Anastasios Kotsikonas
X-Comment: Please send list server requests to listproc@theporch.com
Status: 0

GLOWBUGS Digest 297

Topics covered in this issue include:

- 1) Re: Making your own IF transformers
by jeffd@coriolis.com (Jeff Duntemann)
- 2) Re: Making your own IF transformers
by jeffd@coriolis.com (Jeff Duntemann)
- 3) Re: Making your own IF transformers
by jeffd@coriolis.com (Jeff Duntemann)
- 4) Re: Making your own IF transformers
by jeffd@coriolis.com (Jeff Duntemann)
- 5) Re: Making your own IF transformers
by Steve Byan <steve@hi.com>
- 6) Re: Making your own IF transformers
by mjsilva@ix.netcom.com (michael silva)
- 7) Re: Making your own IF transformers
by Steve Byan <steve@hi.com>
- 8) Re: Making your own IF transformers
by W4AOS@aol.com
- 9) Re: Making your own IF transformers
by jeffd@coriolis.com (Jeff Duntemann)
- 10) Re: Making your own IF transformers
by herr@ridgecrest.ca.us (Michael Herr)
- 11) Re: Making your own IF transformers
by Bob Roehrig <broehrig@admin.aurora.edu>
- 12) Printed Circuit board program
by wj5j@juno.com (John D Hensley)

Date: Fri, 20 Sep 1996 08:44:32 -0700
From: jeffd@coriolis.com (Jeff Duntemann)
To: Lrware@aol.com
Cc: glowbugs@theporch.com
Subject: Re: Making your own IF transformers
Message-ID: <1.5.4.32.19960920084139.00eba0b8@ntserver.coriolis.com>

At 09:40 PM 9/19/96 -0400, you wrote:

>Your upper (adjustable) coil will experience changes in stray
>capacitance to your copper shield can as you move it up/down
>in relation to your copper pipe end (top). This will cause tuning
>problems. Avoid this by setting your degree of coupling
>before final tuning of your tanks...

I would guess this to be a three-step process: Set frequency, set degree of coupling, and then tweak frequency to compensate for the effect you cite. No big deal, really, given an adjustable signal generator.

>For lower freq. IF cans, they are sometimes made of mu-metal
>to increase magnetic shielding.... Copper may not shield as
>well as you would like.

What is mu-metal? And does aluminum work better than copper for magnetic shielding? Aluminum tubing that size isn't as easy to come by but I can get it. The real snag is a nice tight-fitting aluminum cap.

But heck, I'll just try it with copper and see what happens.

Thanks for the feedback!

--73--

--Jeff Duntemann KG7JF
Scottsdale, Arizona

Date: Fri, 20 Sep 1996 08:48:28 -0700
From: jeffd@coriolis.com (Jeff Duntemann)
To: John Kolb <jlkolb@cts.com>
Cc: glowbugs@theporch.com
Subject: Re: Making your own IF transformers
Message-ID: <1.5.4.32.19960920084535.00ec733c@ntserver.coriolis.com>

At 06:43 PM 9/19/96 -0700, KK6IL wrote:

>Rather than make mechanically adjustable, why not make the two
>inductors on two toroid cores, and use capacitive coupling?
>Should be both simpler and smaller.

```
>
>
>-----| |-----
>      |   |   |   |   |   |
>      |   )       L2    C2
>C1 --- ( L1
>      --- )       etc.
>      |   (
>      |   |
>-----
>
```

I assume the cap between the two sides is variable to change the degree of coupling. This is easy and I could rig one in an hour for some tests. I also assume that the less capacitance between the two sides, the looser the coupling. Any other tips on this design? I didn't learn this one for my FCC Second Class Commercial...

--73--

--Jeff Duntemann KG7JF
Scottsdale, Arizona

Date: Fri, 20 Sep 1996 08:55:58 -0700
From: jeffd@coriolis.com (Jeff Duntemann)
To: Bill Sorsby <bill.sorsby@dlep1.itg.ti.com>
Cc: glowbugs@theporch.com
Subject: Re: Making your own IF transformers
Message-ID: <1.5.4.32.19960920085305.00ecfcc8@ntserver.coriolis.com>

At 09:18 PM 9/19/96 -0500, you wrote:

>I've got a BC-779-A Super-Pro which uses
>all copper IF cans. It's probably the best performing Super-Pro I've got.
>The others use all aluminum IF cans. In case you're not familiar with
>Super-Pro's they have excellent selectivity (even by today's standards).

My dad was a radio operator in AACs in North Africa during the War, and talked about the military Super Pros a lot. I looked for one for him before he died but never located anything in reasonable shape. Sounds like a helluva receiver. Since I scored a 75A-4 for \$80 I pretty much stopped looking.

>The best material to use, though, would be a metal designed to provide a
>high degree of magnetic shielding. I used to think mu-metal was best,
>although a discussion here a while back suggested that a newer material was
>better and that mu-metal was no longer available. (I also used to think
>mu-metal was a generic term rather than a product name!)

I've not heard of mu-metal; no idea whether it's aluminum based or what. If you know, please summarize.

Thanks for your help. I'll let everybody know what comes of this. I'm selling a car and rolling the proceeds into a spectrum analyzer, which should make testing the performance of IF cans a snap. Should have it by November with any luck.

--73--

--Jeff Duntemann KG7JF
Scottsdale, Arizona

Date: Fri, 20 Sep 1996 09:09:24 -0700
From: jeffd@coriolis.com (Jeff Duntemann)
To: gsraven@cris.com
Cc: glowbugs@theporch.com
Subject: Re: Making your own IF transformers
Message-ID: <1.5.4.32.19960920090631.00ed5088@ntserver.coriolis.com>

At 08:55 PM 9/19/96 -0500, you wrote:

>You are missing one major variable: the Q of each of the resonators. This
>will dictate the coupling factor required for a flat frequency response and
>also the bandwidth of the coupled filter.

I suspect this was why IF cans all used Litz wire.

>Well, the slugs adjust the resonant frequency. The coupling is essentially
>fixed by the physical configuration of the 2 coils. Usually the 2 coils are
>on the same axis (at least the ones I have dismantled), and the coupling
>factor is adjusted by the distance between them. The slugs probably have
>some minor impact on the coupling factor, but the primary variable is the

>spacing between the coils.

I know I have IF cans with *both* trimmers and slugs. That's why I assumed the slugs adjusted the coupling, and I envisioned the physics as the slugs increasing or decreasing the flux density passing through both inductors as they move further away from or closer to the inductors. I would almost bet that this is the case...to a degree. But you're right, commercial cans are designed for a specific application. Ahh, and another thing I've wondered about for years that you may know: What is the difference between "input" and "output" IF transformers? I'm guessing impedance matching into typical tube stages, but it would be good to know for sure.

>>The points about which I'm unsure are these:

>>

>>* Is sliding one winding up and down to adjust its distance from the other
>>winding an effective method of controlling the coupling? I've never seen
>>this done on a commercial IF can. Is there any downside vis-a-vis using a
>>slug down the middle?

>

>Yes, it will work. The commercial IF cans were designed for a particular
>bandwidth, and as such they had a fixed coupling. I have heard that the
>coupling was determined empirically, even though there are formulae for
>this. Also, the shield can will affect the Q of the coils and also the
>coupling factor, but I don't recall seeing a formula taking the shield into
>account.

Empirical is my middle name. The formulas typically only get me in the ballpark.

>>My target IF frequency is 1.6 or 1.7 mc.

>

>You will have to have one whopper Q factor to get good selectivity at this
>frequency. For example, the coils in the 455 kHz IFs in AM broadcast radios
>have a Q of about 100. That is a pretty good Q, and the resultant bandwidth
>is 2 times square root of 2 times coupling factor time resonant frequency.
>The coupling factor for flat response assuming equal Q for the primary and
>secondary is $1/Q$. So the 3 dB bandwidth is $2 \times 1.414 \times 0.01 \times 455 \text{ kHz} = 12.9 \text{ kHz}$
>which is about right for a 10 kHz wide AM signal. To get the same
>bandwidth, you would have to have a Q of 350. Assuming you want decent
>selectivity on the crowded ham bands, you better go for something like 2
>kHz, for which you would need a Q of 2333 !!!!

Yowch! I haven't really "done the math" to that level yet. I suppose I could use larger wire and fewer turns for the inductors, with larger trimmers to resonate. I don't know how much more Q that would buy me--don't have a Q meter either.

I need to do more research, but I know that there are Q multipliers that add

regeneration to the first IF and get an effective Q almost as high as you want it to be. Putting a tickler on the telescoping tubing would be a snap...definitely have to look into that. Or wouldn't that help in this case? That would allow me to "choke up" on the skirts for CW work and spread them out for AM.

>This is why the ARC-5 and triple conversion ham receivers went to very low
>IFs like 50 or 80 kHz to achieve good selectivity using LC filters. Even
>the modern Drake R8 uses a very low IF frequency to achieve this. Of
>course, the image problem has to be solved using triple conversion or image
>cancelling mixers in the case of the Drake.

I'm not ready for triple conversion yet. One step at a time. I'll get there!

Thanks for your generous response here. I'll let everybody know how this thing goes.

--73--

--Jeff Duntemann KG7JF
Scottsdale, Arizona

Date: Fri, 20 Sep 1996 14:42:29 -0400
From: Steve Byan <steve@hi.com>
To: jeffd@coriolis.com
Cc: glowbugs@theporch.com
Subject: Re: Making your own IF transformers
Message-ID: <v03007800ae6895add063@[140.243.30.128]>

I remember seeing an article recently on making double-tuned circuits. I think it was in QEX, but it might have been in Communications Quarterly. Sometime in the past year or two. I'll try to dig it up.

Regards,
-Steve

Steve Byan
Hitachi Computer Products (America), Inc.
1601 Trapelo Road
Waltham, MA 02154

internet: steve@hi.com
phone: (617) 890-0444
FAX: (617) 890-4998

Date: Fri, 20 Sep 1996 12:26:19 -0700
From: mjsilva@ix.netcom.com (michael silva)
To: glowbugs@theporch.com
Subject: Re: Making your own IF transformers
Message-ID: <199609201926.MAA16081@dfw-ix6.ix.netcom.com>

Regarding litz wire, the reading I've done says the benefits disappear above 1-2 MHz, so you probably won't be missing much at 1.6 MHz. As far as getting adequate selectivity, you could always try some regeneration in the IF stage. Anyway, those 4-inch high IF transformers are sure going to look impressive! Hope you'll be using tubes that can stand the comparison...

>selling a car and rolling the proceeds into a spectrum analyzer, which
>should make testing the performance of IF cans a snap.

Now that's dedication! (Wish I had one...)

73,
Mike, KK6GM

Date: Fri, 20 Sep 1996 16:06:21 -0400
From: Steve Byan <steve@hi.com>
To: glowbugs@theporch.com
Subject: Re: Making your own IF transformers
Message-ID: <v03007802ae68a77afedf@[140.243.30.128]>

>Anyway, those 4-inch high IF
>transformers are sure going to look impressive! Hope you'll be using
>tubes that can stand the comparison...

I remember seeing pictures of some Hammarlund air-core IF transformers (two large pi windings on a wooden dowel, resonated with two Hammarlund air trimmers) in one of Lindsay's reprints - I think it was the Gernsback 1934 Official Shortwave Manual, but it might have been the ARRL Handbook receiver reprint. The article included modifying them for some reason; maybe adding a tickler for regeneration or some-such. They did look impressive, especially when surrounded by those big tube-shields for the old pre-war tubes. And yes, you did slide the pi's along the dowel to adjust the coupling.

Andy Wallace, are you on glowbugs? I imagine your Comet-Pro uses these old-style IF transformers. How about opening it up and giving us a description?

Jeff, you'll definitely need to use tubes with grid-caps and machined-aluminum shield cans. How 'bout some 58's? And ditch the plastic rod - use dowels boiled in parrafin. :-)

Regards,
-Steve

| | |
|---|------------------------|
| Steve Byan | internet: steve@hi.com |
| Hitachi Computer Products (America), Inc. | |
| 1601 Trapelo Road | phone: (617) 890-0444 |
| Waltham, MA 02154 | FAX: (617) 890-4998 |

Date: Fri, 20 Sep 1996 18:24:03 -0400
From: W4AOS@aol.com
To: Glowbugs@theporch.com
Subject: Re: Making your own IF transformers
Message-ID: <960920182402_313698918@emout12.mail.aol.com>

There are two aspects to making your own IF xfmrs. The first is designing a set of transformers to work as a system with your particular IF amplifier tubes to give you a passband shaped the way you want it to be. The second is actually fabricating the unit and providing for shielding, coupling adjustment, and tuning. As in so many things related to boatanchors, the venerable Radiotron Designers Handbook has excellent material on both aspects of the problem. See Chapter 26 of the fourth edition.

There are too many things to consider for me to go into all the details here, but to give you the flavor of the procedure, here are some of the things which must be considered when designing a set of IF transformers. Notice that I keep saying a set, that is because the transformers are in cascade and the net passband shape is the product of all of them, so if you want a response which is three dB down at so many kc off of center, you can't just design one transformer to give you this, you must first decide how many transformers you are going to use in order to know how much wider than the desired overall response you must make the individual transformers in order to get the desired overall response. (with two stages of IF amplification there are three IF transformers.

Next you must decide what the passband should look like. This is usually done by first specifying what the bandwidth is at two different overall attenuations e.g. 3 dB and 40 dB. You don't have complete freedom here as Q and number of stages play a role so the process is often iterative. The

response is usually not flat across the pass band if the pass band is fairly wide such as would be used for AM reception this is a function of the degree of coupling required. In this case you must decide how much ripple (the difference between the response at the peaks and valleys in the pass band) you are willing to accept. Typical values are: 0.5 dB, 1dB, 2dB or whatever.

You must also assume a value of tuning capacitor for the two coils, this must take into account the stray capacity as well as the tube capacity.

With this information in hand you can calculate the required Q and coupling coefficient. Note that this Q is the loaded Q. The plate of the tube driving the transformer loads the coil it drives with its plate resistance and lowers the Q, often quite a bit below the unloaded value. Pentodes are very useful here due to their high values of plate resistance. The output coil of the transformer is in turn loaded by the grid of the tube it is driving. Tube grids are not infinite resistances at IF frequencies, for example the 6SK7 has a plate resistance of 800k and an input resistance of 6.8 meg.(The handbook covers this area too!)

Knowing the tube parameters and the desired Q etc. you can then design the actual inductors, determine their loaded Q and the unloaded Q which they must have to achieve the desired loaded Q. Often when the output IF transformer, the one which drives the typical diode detector is considered, the required loaded Q cannot be achieved due to the loading of the detector which draws current, its equivalent load is generally considered to be about half of the d.c. resistance associated with the detector circuit.

In cases where the desired unloaded Q cannot be achieved there is a more complex procedure given in the Handbook which allows the Q of the primary and secondary windings to be different. With this extra degree of freedom you may be able to find a set of Q's which will provide the necessary response.

I don't mean to scare anyone off who is contemplating doing their own IF transformers, I realize that one can have a lot of fun just going ahead and winding coils and seeing what happens, and I urge all of you who are so inclined to do so.

The section of the handbook which details the IF transformer design procedures is only 17 pages long, including general considerations and guidelines, procedures for undercoupled, overcoupled, and single tuned transformers and several worked examples. The math is not complex and with a little head scratching anyone should be able to master it. If you really want a great feeling try doing it the rigorous way then comparing your specified performance with the actual results and you will be amazed at how much those old geezers were able to do with their wooden calculators, tables and rules of thumb.

I designed a transformer using the procedures given in the handbook, and then simulated the performance with the ARRL's Radio Designer Software, and lo and behold the method worked, the simulated performance was very close to my initial design specifications.

As for the details of actually making the transformer, one thing which should be mentioned is that the coupling is never solely via mutual inductance or capacitance. For example; if you use two coils which are coupled by mutual inductance, there is always some unavoidable capacitive coupling between the two coils due to the capacity between them and between their lead wires, which after all are not that far apart. The effect of mixed coupling as this is called is dependent on the relative phasing of the two forms of coupling, and can lead to an asymmetrical response curve if the phases are opposite.

Every effort should be made to minimize this stray capacitive coupling. For this reason, when taking IF transformers apart it is important to always hook them up the same way, plate, b+, grid return, and grid as they were originally and to align the wires within the shield the same way they were and to run the wires down to the terminals the same way to avoid creating undesirable capacitive coupling.

Again, cheers, have at it and enjoy, I just thought a few words about the engineering approach to IF transformer design might be interesting.

73 Bob w4aos@aol.com

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With this information, you can go to work and calculate the Q required for the

Date: Fri, 20 Sep 1996 16:48:53 -0700
From: jeffd@coriolis.com (Jeff Duntemann)
To: W4AOS@aol.com
Cc: glowbugs@theporch.com
Subject: Re: Making your own IF transformers
Message-ID: <1.5.4.32.19960920164558.00a9eb64@ntserver.coriolis.com>

Bob--

Many thanks for taking so much time to offer your advice. I actually have the fourth edition of Radiotron and I'll curl up with that section soonest.

What you say sounds a little scary at first, but I have to remind myself (and I'll remind everybody else) that you don't have to have an HRO or a 75A4 to make worldwide contacts, especially on CW. My first transmitter was homebrew and a total mess--but I worked 12 states with it before a local club gently encouraged me to retire it in favor of something that was NOT 10% AM modulated by 60 cycle hum.

Not one ham in 10,000 builds superhet receivers anymore, and I would guess only a few dozen have ever designed their own IF transformers. If I can pull that off--whether or not I pull it off well--I figure I'll have done something remarkable, even if I don't end up with a world-class receiver. In no other way could I ever come to understand how IF amps work to a comparable depth.

As Dr. Johnson said of dancing dogs, What matters is not that it dances well, but that it dances at all.

I'll be tempted to call this box The Dancing Dog.

Thanks again for jumping in.

--73--

--Jeff Duntemann KG7JF
Scottsdale, Arizona

Date: Fri, 20 Sep 1996 19:35:25 -0700 (PDT)
From: herr@ridgecrest.ca.us (Michael Herr)
To: glowbugs@theporch.com
Subject: Re: Making your own IF transformers
Message-ID: <v01530503ae69f42fc3e8@[199.120.150.122]>

>
>Not one ham in 10,000 builds superhet receivers anymore, and I would guess
>only a few dozen have ever designed their own IF transformers. If I can
>pull that off--whether or not I pull it off well--I figure I'll have done
>something remarkable, even if I don't end up with a world-class receiver.
>In no other way could I ever come to understand how IF amps work to a
>comparable depth.

>
>--Jeff Duntemann KG7JF

>

Jeff,

I'm not sure that is true anymore. The QRP movement is very heavy into homebuilding. For the most part, the direct conversion receiver has been largely abandoned for the superhet. With the large number of QRP transceivers being offered and most of them superhets, there are a lot of construction going on. Yes, I know this isn't directly glowbug stuff, but a lot of QRPers, such as myself, are building firebottle rigs. It's only time when tube superhets will be built again.

vy 73 es 72

Mike WA6ARA

Date: Fri, 20 Sep 1996 22:45:28 -0500 (CDT)
From: Bob Roehrig <broehrig@admin.aurora.edu>
To: Jeff Duntemann <jeffd@coriolis.com>
Cc: Multiple recipients of list <glowbugs@theporch.com>
Subject: Re: Making your own IF transformers
Message-ID: <Pine.ULT.3.95.960920224349.24572D-100000@admin.aurora.edu>

On Fri, 20 Sep 1996, Jeff Duntemann wrote:

>

> I've not heard of mu-metal; no idea whether it's aluminum based or what. If
> you know, please summarize.

>

Mu-metal was the material used for shields on CRT's (scope tubes) to reduce effects of magnetic fields. I don't think it would be a benefit on IF transformers.

E-mail broehrig@admin.aurora.edu 73 de Bob, K9EUI
CIS: Data / Telecom Aurora University, Aurora, IL

Date: Sat, 21 Sep 1996 00:10:49 PST
From: wj5j@juno.com (John D Hensley)
To: glowbugs@theporch.com
Cc: boatanchors@theporch.com
Subject: Printed Circuit board program
Message-ID: <19960921.001109.4791.15.wj5j@juno.com>

Hellow Glowbug crafters,

Cleaning up a bit I ran across a DOS 3.3 era pc pattern program called Smartwork. I have the manual and program copy in a downsized green binder. These were not very popular years ago because of the dot matrix printing but with ink jet technology, you should be able to fashion some quite nice board layouts for tube or restoration work.

If anyone would like to have it for shipping and anything what so ever from the old junk box, please contact me. Shipping probably 3-4 lbs.

73, Doug WJ5J
Baton Rouge, Louisiana
80 miles NW of New Orleans

End of GLOWBUGS Digest 297
